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SNAP-ON TOOLS CORPORATION  
HARRISBURG, PENNSYLVANIA

NIOSH INVESTIGATOR:  
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## I. SUMMARY

On June 2, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from the Manager of Snap-on Tools Corporation, Eastern Service Center, for evaluation of potential occupational exposure of tool-repair technicians at this facility to a cleaning solvent known as Safety Kleen 105 Solvent-MS. This solvent is composed of mineral spirits with very small amounts of a dye and an anti-static agent, which contain chromium [III] oxide, and unspecified calcium and chromium salts, respectively.

An environmental evaluation was conducted on June 26 and 27, 1986. Forty long-term time-weighted average (TWA) air samples were collected for the constituents of mineral spirits. Sixteen were 8-hr personal breathing-zone samples, 10 were 8-hr area samples, and 14 were process samples from the solvent-wash stations. The personal exposure levels ranged from 20 to 95 mg/m<sup>3</sup>, well below the relevant evaluation criteria. Almost all of the area-sample levels were less than the personal exposure levels. Only one of the process sample results exceeded any of the evaluation criteria; this helps show chronic overexposure to be unlikely, as no worker ever spends an extended time as close to the process as the process samplers were placed. In addition, two direct-reading detector tubes and eight readings from a direct-reading photoionization detector were used to characterize the short-term variations in the levels due to various activities. The results of these measurements were reasonably consistent with the long-term results, and they indicated that the levels rise during air-hose use for drying. Generally, the highest levels of mineral spirits constituents were found in the pneumatic-tool repair room (particularly the north end). Apparently, the escape of airborne solvent from the solvent-stations into the room air is the most significant source of the personal exposures and ambient levels.

Five 8-hr TWA air samples, three process and two background area, were collected for trace chromium and calcium. Two 8-hr TWA process air samples for chromium (VI) were also collected. There does not appear to be measurable airborne calcium at the exhaust hoods in excess of the measured background levels. No chromium in any form was detected.

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Based upon the results of this investigation, the NIOSH investigator concluded that there does not appear to be a potential health hazard associated with Safety Kleen 105 Solvent-MS cleaning solvent as used at this facility. Still, two recommendations for simple modifications of the ventilation hoods in the pneumatic-tool repair room are made in Section VI of this report, as it is good practice to reduce exposure levels when doing so is relatively simple. Furthermore, it is recommended that the usage of some of the other chemical products used intermittently as cleaning solvents, and for other purposes, particularly those containing 1,1,1-trichloroethane and methylene chloride, be reviewed.

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KEYWORDS: (SIC - 7699, 7629) Mineral spirits, chromium, calcium, solvent parts-cleaning.

## II. INTRODUCTION/BACKGROUND

On June 2, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation (HHE) from the Manager of Snap-on Tools Corporation Eastern Service Center for evaluation of potential occupational exposure of tool-repair technicians at this facility to the components of a cleaning solvent known as Safety Kleen 105 Solvent-MS. One of the employees at the facility has reported chronic health problems, and his personal physician recommended an evaluation of the workplace environment.

The Eastern Service Center occupies about one-third of Snap-on Tools Corporation's building on U.S.22 east of Harrisburg, Pennsylvania. The remainder of the building is a sales office, which is operationally and physically (except for the sharing of a common wall) separate from the Service Center. The Service Center repairs three types of tools, including torque hand-tools, electronic tools (such as engine analyzers), and pneumatic-powered tools. The pneumatic-tool repair area, where approximately nine employees work, is in a separate room from the other repair areas, which are in the main large central room along with the shipping and receiving department. About 10 employees work in the main room. Additional smaller rooms include offices (in which a small number of additional employees work), lunchroom, and restrooms. The pneumatic-tool repair room is rather long and narrow and runs north to south along the western edge of the Service Center; it is divided into north and south areas by the testing room which covers much of the space near the center of the room. The Service Center has central heating/ventilation/air conditioning (HVAC), with the unit on the roof; the system has an "economizer" which automatically utilizes outside air when conditions warrant. The system is not in any way connected to the sales-office portion of the building.

Tools to be repaired, particularly the pneumatic tools, are often quite dirty and/or greasy, and are frequently in need of thorough cleaning before and after disassembly. Cleaning is most commonly accomplished by taking a tool or part to one of three solvent wash stations in the Service Center, two of which (Snap-on Parts Washer Model YDM 32) are located in the pneumatic-tool repair room (one each at the north and south ends) and one of which (Snap-on Parts Washer Model YDM 126) is located in the torque-tool repair area. Each solvent station consists of a wash basin with a dispenser spout for the solvent. The solvent is pumped from a drum under the basin when a foot pedal is depressed. The basin area has a partial enclosure connected to an exhaust ventilation system. The solvent, Safety Kleen 105 Solvent-MS, is recirculated after draining to the drum. A vendor periodically exchanges each drum of dirty solvent for a fresh supply. The solvent stations in the pneumatic-tool repair room is used quite often, whereas the one in the torque-tool repair area is not used very frequently.

Safety Kleen 105 Solvent-MS is nearly 100% mineral spirits, which is a petroleum distillate product with a boiling range of 150 to 200°C consisting mainly of C<sub>9</sub>-C<sub>12</sub> hydrocarbons (>80% aliphatic)[1]. The solvent also contains two additives in the parts-per-million range. One of these is Oil Green Dye, the other ASA #3 Anti-Stat, an anti-static agent. Oil green is chromium (III) oxide [2]. ASA #3 Anti-Stat is 50% xylene (the solvent for this agent) and 50% other components "not considered hazardous by OSHA Hazards Communication" [3]. These other components are calcium and chromium (unspecified valence) salts (the exact identities of which are considered proprietary by the manufacturer of this agent) and a polymer stabilizer [4].

NIOSH investigators conducted an industrial hygiene survey on June 26 and 27, 1986. On August 4, 1986, a letter serving as an interim report on this survey was sent to the Manager of the Service Center. A telephone call was made to the Manager on December 15, 1986, to inform him of the status of the HHE and update him on the findings. Also, a letter serving as a second interim report was sent on February 24, 1987.

### III. EVALUATION DESIGN AND METHODS

Environmental monitoring and ventilation testing were the primary survey techniques employed during the NIOSH industrial hygiene survey on June 26 and 27, 1986. Additionally, however, brief and informal discussions were conducted with some of the employees to obtain additional background information about the operations of the Service Center (with respect to exposure to the Safety Kleen solvent) and an indication of any symptoms that they may have experienced which subjectively seemed related to exposure.

The environmental monitoring strategy emphasized air sampling for mineral spirits constituents, since mineral spirits is the main component of the solvent in question, as well as the only component which will volatilize to any measureable degree. Air sampling for chromium (total) and calcium was also conducted because some aerosolization of the solvent was expected. Air samples also were collected specifically for chromium (VI) compounds (which are considered separately due to their unique hazardous properties; see the discussion of toxicology in Part IV, Evaluation Criteria) because the chromium compounds in the ASA #3 additive were not identified. However, it was assumed to be unlikely that the chromium compounds would turn out to be chromium (VI)-containing.

Forty long-term time-weighted average (TWA) samples were collected for the constituents of mineral spirits (20 on each of the two days). Additionally, two direct-reading detector tubes were used to provide short-term process measurements of hydrocarbon concentrations at the two most frequently-used solvent stations (i.e., those in the pneumatic-tool repair area). Also, a direct-reading photoionization detector was used to provide a rough indication of the variation in hydrocarbon concentrations, compared with those measured at the solvent stations. Eight readings, one a process sample at a solvent station, four in workers' breathing zones, and three area samples (one of which was an outdoor background reading), were recorded with this instrument over time periods of 2 to 13 min.

Of the 40 long-term TWA air samples for mineral spirits, 16 were 8-hr personal breathing-zone samples for the eight repair technicians in the pneumatic-tool repair area, 6 were 8-hr area samples also in that area, 4 were 8-hr area samples in the other repair areas (2 each in the torque and electrical areas), and the remaining 14 were process samples from the solvent stations. Twelve of these were 4-hr samples collected in the pneumatic area, while the other two were 8-hr samples from the torque area. It was evident from the volume of parts being cleaned with the solvent, the noticeable solvent odor, and the number of people in the smaller, separate pneumatic area that the pneumatic area was the site of the most significant solvent exposures. Therefore, the other areas were not emphasized in the sampling strategy.

Five 8-hr TWA air samples (three process and two background area) were collected for trace chromium and calcium. Two 8-hr TWA process samples for chromium (VI) were also collected. The process samples were collected at the solvent stations in the pneumatic area, while the background samples were collected in the center part of the pneumatic area, away from the work stations and solvent stations. Personal and general area sampling were not employed due to the unlikelihood of detecting measureable airborne levels of these substances at locations away from the source of the aerosolized solvent.

The ventilation testing consisted of an assessment of the airflow patterns at each solvent station exhaust hood using smoke tubes, as well as dimensional and traverse face velocity measurements.

Several measurement methods were used during this evaluation. The time-weighted average air samples were all collected using portable air sampling pumps which draw air at known rates through specific sampling media. For the mineral spirits, the collection media was charcoal in glass tubes, and the flow rate used was 20 cubic centimeters of air per minute (cc/min). Analysis was by gas chromatography with flame ionization detection after desorption with carbon disulfide, per NIOSH Method 1550. For trace chromium and calcium in aerosol, and also chromium (VI), the collection media were placed in 37-mm-diameter plastic cassettes, and the flow rate used was 2.7 L/min. For trace chromium and calcium, the collection media were 0.8-um-pore cellulose-ester membrane filters. Analysis was by inductively coupled argon-plasma atomic emission spectroscopy, after ashing with nitric and perchloric acids, per NIOSH Method 7300. For chromium (VI), the collection media were 5-um-pore PVC-membrane filters. Analysis was by visible absorption spectroscopy after a reaction to form a chromate-diphenylcarbazide complex (the analyte), per NIOSH Method 7600. The direct-reading devices used for hydrocarbons were a portable H\*Nu\* Photo-ionizer, and Drager\* Hydrocarbons 0.1%/b detector tubes and pump. Air velocities were measured with an Alnor Jr.\* swinging-vane anemometer.

#### IV. EVALUATION CRITERIA

##### A. Toxicology

Mineral Spirits - are clear colorless liquids with a pleasant sweetish odor. The properties and boiling range are very similar to Stoddard solvent [1]. They are commonly used as a general-purpose industrial solvent and as a thinner in paints and varnishes. Prolonged or repeated contact with the skin can cause moderate skin irritation or dermatitis due to the defatting action of this solvent [5]. As discussed below, it is believed that the

likelihood of systemic toxicity due to absorption of mineral spirits through the skin is probably small. Ingestion of mineral spirits can cause gastrointestinal irritation, nausea, vomiting, and diarrhea. If swallowed, aspiration into the lungs causes chemical pneumonitis which can be fatal. Airborne concentrations of mineral spirits above 2,500 mg/m<sup>3</sup> have been shown to cause nausea and vertigo in humans [6], as well as possible eye irritation at concentrations as low as 900 mg/m<sup>3</sup> [5]. Inhalation of mineral spirits vapors can irritate the upper respiratory tract and will depress the central nervous system resulting in dizziness, weakness, fatigue, nausea, headache, and under conditions of severe exposure, unconsciousness and possible asphyxiation. The cardiac system may also be affected [7]. Chronic inhalation exposures to Stoddard solvent have resulted in hepatic (liver) and hematopoietic changes [7] (such as bone marrow hypoplasia [8]). Kidney damage can occur from exposure to Stoddard solvent [8]. In chronic animal studies, kidney effects, as well as effects on the lung, have been reported [5].

The primary components of mineral spirits, aliphatic hydrocarbons, are non-polar lipophilic compounds and would in theory, therefore, be expected to permeate the skin by simple diffusion. This effect would be enhanced if the stratum corneum were removed as in dermatitis. Therefore, the possibility of systemic effects by skin absorption must be considered. Indeed, dermal exposures to Stoddard solvent have caused jaundice [8]. In a chronic study of rats, the mineral spirits component n-decane was skin absorbed [5]. A thorough washing of the skin has been recommended as part of the treatment for hydrocarbon [9] and kerosene (another petroleum distillate somewhat similar to mineral spirits) toxicity [10]. This evidence supports the possibility of sufficient cutaneous absorption of mineral spirits for systemic toxicity.

Conversely, more detailed discussions of the hazards associated with another petroleum distillate, gasoline (which may have a greater aromatic content, and thus a greater potential for absorption as well as for higher toxicity, than mineral spirits or kerosene [11]), indicate that the relative importance of cutaneous absorption of gasoline is minor compared to the inhalation which is usually occurring contemporaneously. In one reported case involving extended immersion in gasoline, substantial cutaneous absorption was suspected, but inhalation dominated the picture [12]. Machle [11] states, "There is no conclusive evidence that systemic poisoning from gasoline can be produced in man by cutaneous absorption alone...the hazard...would seem slight indeed and of little practical importance when compared with the exposure to vapor that usually coexists." It is the opinion of a NIOSH physician consulted about this problem that a similar statement can be made about mineral spirits [13]. Such a situation is not unexpected because of the small surface area of the skin compared with the lungs, and the typically slow rate of dermal absorption compared to other routes. Components of mineral spirits, such as n-decane, undecane, and others, have been dissolved in dimethyl sulfoxide, acetone, and cyclohexane for animal studies, apparently to facilitate skin penetration [14][15], implying that these alkanes do not permeate the skin (of mice, in these cases) as well as many other lipophilic compounds. The conclusion is thus reached that it is very unlikely that dermal absorption will be of as great of importance as inhalation for petroleum distillates such as mineral spirits.

The 10-hour TWA exposure limit recommended by NIOSH is 350 mg/m<sup>3</sup> with a 15-min ceiling limit of 1800 mg/m<sup>3</sup>. These limits were established to prevent the symptoms of central nervous system depression, upper respiratory irritation, and chronic responses based on the projected toxicities of the major aliphatic

(70-90%) and aromatic (10-30%) components of mineral spirits [16].

Chromium - is a metallic element with an atomic weight of 51.996. It can have a valence of 2, 3, or 6, and forms a wide variety of compounds and alloys. Divalent chromium (chromous) and trivalent chromium (chromic) compounds, and chromium metal, apparently have a low order of toxicity. Pulmonary disease has been reported among workers exposed to these substances. Also, dermatitis has been reported in workers handling trivalent chromium compounds [5].

Hexavalent chromium, or Cr(VI), is the form found in chromic acid, chromates, dichromates, and polychromates [5]. This form is much more toxic than the other forms [17]. Chromium metal was first isolated in 1798, and as early as 1827, dermatitis and ulcerations of the skin and nasal septum ("chrome holes") were noted in workers handling the hexavalent compounds [5]. The occupational health literature abounds with evidence that exposure to the hexavalent compounds may cause these ulcerations, irritant and allergic contact dermatitis, and respiratory irritation of various types, both acute and chronic. Kidney damage (when hexavalent chromium compounds are absorbed through damaged skin), liver and gastrointestinal damage, and blood changes have also been reported [5,8,17]. Epidemiological studies of workers have shown that certain water-insoluble forms (calcium chromate, lead chromate, zinc chromate [17]) cause an increased risk of lung cancer [5,8,17], primarily bronchogenic carcinoma. In addition, one epidemiological study has also shown, with clear a dose-response relationship, increased risk of lung cancer from certain soluble forms [17]. NIOSH considers all chromium (VI) compounds to be carcinogenic, except for the following soluble compounds only: chromium (VI) oxide (chromic acid anhydride) and the chromates and dichromates of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium [8].

Calcium - is a metallic element and an essential mineral in the human body. Little information is available to indicate the effects on health from overexposure to calcium and its compounds in general, although the caustic forms calcium hydroxide and calcium oxide are irritants of the skin, eyes, and respiratory system [5,8,18].

## B. Environmental Criteria

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health

effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are

often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

The following table contains the Permissible Exposure Limits promulgated by the Occupational Safety and Health Administration (OSHA PELs) [19], the ACGIH TLVs [5], and the NIOSH Recommended Exposure Limits (NIOSH RELs) [20] for the substances studied in this HHE.

Table.  
Environmental Criteria.

SUBSTANCE	ACGIH TLV		OSHA PEL		NIOSH REL	
	8-hr TWA (mg/m <sup>3</sup> )	15-min STEL(1) (mg/m <sup>3</sup> )	8-hr TWA (mg/m <sup>3</sup> )	CEILING (mg/m <sup>3</sup> )	10-hr TWA (mg/m <sup>3</sup> )	15-min CEILING (mg/m <sup>3</sup> )
Mineral Spirits	-	-	-	-	350	1800
Stoddard Solvent	525	-	2950	-	350	1800
Calcium Oxide	2	-	5	-	-	-
Calcium Hydroxide	5	-	-	-	-	-
Calcium Silicate	(D)	-	-	-	-	-
Calcium Carbonate	(D)	-	-	-	-	-
Chromium (VI): all	-	-	-	0.1 (2)	-	-
"non-carcinogenic"	0.05 (3)	-	-	-	0.025(4)	0.05(4)
"carcinogenic"	0.05(A)(3)	-	-	-	0.001 (4)	-
Chromium metal (as Cr)	0.5	-	1	-	-	-
Chromium (not VI), in- soluble salts (as Cr)	-	-	1	-	-	-
Chromium (II) and (III) (as Cr)	0.5	-	0.5	-	-	-

1. Short-Term Exposure Limit.

2. Chronic acid and chromates, as CrO<sup>3</sup>.

3. As Cr. ACGIH defines certain water-insoluble chromium (VI) compounds as carcinogenic (see text); all other chromium (VI) compounds are considered non-carcinogenic.

4. As Cr (VI). NIOSH defines certain water-soluble chromium (VI) compounds as non-carcinogenic (see text); all other chromium (VI) compounds are considered carcinogenic.

A. Designated human carcinogen by ACGIH.

D. Considered a "nuisance dust" which carries a TLV (TWA) of 10 mg/m<sup>3</sup> for total concentration and 5 mg/m<sup>3</sup> for the respirable fraction.

V. RESULTS AND DISCUSSION

A. Air Sampling for Mineral Spirits

TWA Air Sampling - The results of the TWA air samples for mineral spirits constituents are summarized in Tables I through VII. Table I summarizes the results of the personal samples, and Table II provides summary statistics for these results. All measured personal exposure levels were well below all environmental evaluation criteria listed in Section IV of this report. Overall, there is not great variability in these results. The variability which is present, however, subjectively appears to be correlated with the workers' locations. Exposures tended to be greater among those stationed at the north end of the pneumatic-tool repair room than among those stationed at the south end; in fact, the geometric 95% confidence limits on these two data sets are mutually exclusive (i.e., their ranges do not overlap) (see Table II). Additionally, the variation appears to correlate with the individuals themselves, perhaps reflecting differences in work practices. This was determined by comparing each person's first- and second-day exposures. Great consistency was seen from day to day, compared to some variability from person to person.

Table III summarizes the results of the TWA area air samples for mineral spirits constituents, and Table IV provides summary statistics for these results. The environmental evaluation criteria listed in Section IV of this report are applicable to personal exposure levels, not area levels; still, all measured area levels were well below the criteria. Almost all of these levels were also less than the personal exposure levels. Since the area samples were collected at the work benches, this finding indicates that a significant source of exposure (and for most of the workers the most important) is actual work at the solvent stations, rather than the extended exposure to the ambient room levels. (The ambient room levels are due to carry-over of solvent on tools and parts to work benches, and/or the escape of airborne solvent from the solvent stations into the general room air. This is discussed further in a subsequent paragraph.) Overall, there is little variability in these results. The variability which is present, however, subjectively appears to be correlated with the location of the work bench or area. Levels tended to be greater at the north end of the pneumatic-tool repair room than at the south end; in fact, the range of measured levels for these two data sets are mutually exclusive (see Table IV). The levels measured in the testing room were approximately in between the previous two groups of data, while the levels in the electrical- and torque-tool repair areas were evidently the lowest, as they were all below the analytical detection limit. No apparent correlation between the overall variability and the day of sampling was evident.

Table V summarizes the results of the individual TWA process air samples for mineral spirits constituents, which were collected at the exhaust hoods for the solvent stations. By combining data from individual samples collected at the same locations on the same days but at different times, the 8-hr TWAs provided in Table VI were derived. Table VII provides summary statistics for the 8-hr TWAs. The environmental evaluation criteria listed in Section IV of this report are not applicable to process sampling data since no one is exposed to the solvent as closely and extensively as were the samplers. A comparison of the measured levels with the criteria does help illustrate how unlikely a chronic overexposure situation is in the facility. A comparison of the higher measured levels at the process with the lower personal and area levels in the

facility is consistent with the conclusion that a significant source of worker exposure is work at the solvent stations. The variability which is present in the data appears to be correlated with the location of the sampler with respect to the exhaust hood. Levels were greater at the right side of the hood at the north end of the pneumatic-tool repair room than at the left side, which is surprising because the target filter is on the left side near where the sampler was located. The latter levels were in turn greater than those at the top of the hood at the south end, or inside the hood in the torque tool repair area. Although the pneumatic south-end hood was used much more frequently than the one in the torque area, the location of the sampler inside the torque-area hood probably accounts for the greater levels measured there. The range of measured levels for each of these four data sets are mutually exclusive (see Table VII). Some fluctuation of levels from the morning to the afternoon is evident from the data, but no trends in this regard were noted, either overall or within sets of samples at a given location. The day of sampling apparently was not a source of overall variability. Overall, the data indicate that emissions are rather well controlled, but, since the measurements are TWAs, it must be recognized that brief excursions to much higher levels can and probably do occur. Such episodes would carry a possibility of briefly much higher exposures to workers than their TWA exposure levels.

Short-term Air Sampling (Direct-reading Measurements) - The results from the direct-reading measurement devices for airborne mineral spirits constituents are summarized in Table VIII. Extreme caution must be used in interpreting the results in Table VIII, as they are all based on the detector tube data which has a precision of only  $\pm 35\%$  at best in this concentration range. The numerical results of the TWA samples have much greater accuracy than the direct-reading results, and they define the true range of exposures. The results in Table VIII are reasonably consistent with those of the TWA samples, but are most useful only from a qualitative standpoint: they provide an indication of the variation in levels associated with specific activities. Specifically, they indicate that the levels rise during air-hose use for drying, presumably due to aerosolization and/or increased vaporization. They also indicate that the movement of parts wet with solvent into the room ("carry-over," discussed in a previous paragraph) is not measurably a source of locally higher levels; therefore, the escape of airborne solvent from the solvent-stations into the general room air is most likely the source of the ambient room levels of solvent. The data also show uniformity in the levels in the pneumatic area, which are higher than those in the main room. This in turn indicates that the central ventilation does not cause the ambient levels throughout the facility to be homogeneous; rather, it appears that much of solvent vapor generated leaves the building before it can be recirculated.

#### B. Air Sampling for Calcium and Chromium

The results of the TWA air samples for calcium and chromium are summarized in Tables IX, X, and XI. Table IX summarizes the results of the process and background area samples for calcium. There does not appear to be measurable airborne calcium at the exhaust hoods in excess of the measured background levels, and all results are far below the environmental criteria listed in Section IV of this report. Table X summarizes the results of the process and background area samples for chromium (total), while Table XI summarizes the results of the process samples for chromium (VI). No chromium in any form was detected.

C. Ventilation Measurements

The quantitative results of the ventilation measurements at each of the solvent stations are shown in Figure 1. Based on these figures, the values in Table XII were calculated. The qualitative assessment provided by the smoke-tube tests indicates that the flow patterns are generally good at all hoods, with no unusual eddies or escaping streams and with flows tending to move contaminants away from the breathing zones of technicians while working at solvent stations. Performance criteria for local exhaust ventilation systems recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) [21] call for 75 feet per minute (fpm) minimum velocity at any control point and at least 150 fpm average face velocity under these conditions. The former is for control of vapor and the latter the aerosol particulates from the pressurized-air spray. The volumetric flow rates are provided only for informational purposes, such as for considering the cost of conditioning (i.e., heating or cooling) the make-up air replacing the exhaust. The lowest velocity measured at the pneumatic area (north end) local exhaust system hood, only 25 fpm, does not meet the criteria, nor do the average face velocities at both hoods in the pneumatic area (although at the south-end hood it is only marginally low).

Based on the linear face velocity data in Figure 1 and Table XII, it is apparent that the solvent station exhaust ventilation at the south end of the pneumatic area is more effective than that at the north end. This conclusion is supported by the results of the TWA samples for mineral spirits constituents, discussed earlier, which indicated lower levels at the south end. The data in Figure 1 showing lower face velocities at the lower right-hand corner of the hoods than at other locations may account for the higher airborne levels of mineral spirits constituents at the right side compared to the left side found by the process samples discussed previously. The same type of statement can be made about the higher face velocities at the top compared to along the sides.

D. Informal Discussions with Employees

The informal discussions conducted with some of the employees provided little indication that the workers at this facility, other than the one individual for whom this HHE was requested, have

experienced symptoms which subjectively seemed related to exposure, with the exception of dry, irritated skin on the hands.

VI. RECOMMENDATIONS

Although overexposures to the airborne mineral spirits constituents probably do not occur at the facility, it is nevertheless good practice to reduce exposure levels when simple methods of doing so are available. Furthermore, the pneumatic area would probably be more agreeable for the technicians if the levels were lower, as an initial odor and a residual taste were noticed by the NIOSH investigators from exposure at the current levels. Therefore, two recommendations for modification of the ventilation hoods in the pneumatic area are made. Both of these, especially the first, are very simple and could probably be made using stiff fiberboard, at least until the recommendations are proven practical in use.

The recommendations are (see also Figure 2): 1) The top edge of the hood opening (north-end hood) should be extended downward, just as that edge of the south-end hood was previously lowered. This alone should upgrade the performance of the former to the level now found in the latter. Also, both of these hoods should have this same edge extended downward even further, but only if this change would not interfere with the work being done. The reduction in area of the openings thus provided will cause the face velocities to rise as is desired. 2) The enclosures on these hoods should be extended outward to fully enclose the basins. Also, at the left side of each opening (near the target filter), the enclosure should turn the corner and come a short distance across the front of the basin, as far as is practical without interfering with the work. Furthermore, the target filter locations should be changed somewhat toward the back left corner of the enclosures, but only if the technicians do not find it awkward to aim the airhoses at the revised target locations. This set of changes will provide better enclosure and capture, especially for the aerosol generated when the air hoses are used, and the extensions along the front edges will also further decrease open area for further velocity increases.

More extensive modifications of the pneumatic-area hoods, including continuous fan operation and/or doors on these hoods, could also be employed. Such modifications, which would address the evaporation of solvent residue from the basins that apparently continues after shut-off, are not indicated by the results of the environmental monitoring conducted during this HHE. Specifically, the very low exposures documented in this facility do not justify extensive modifications. Also, given that for most of the workers the most important source of exposure is actual work at the solvent stations, rather than the extended exposure to the ambient room levels, these modifications are of less value in controlling exposures than those recommended in the previous paragraph.

After the recommended physical modifications have been made to the hoods, the resulting air velocities should be measured and flow adjustments made by the company's heating/ventilation/air conditioning (HVAC) contractor to insure that the minimum standards discussed above are met.

At this time it is believed that the exposures to mineral spirits due to the solvent station in the torque-tool repair area are very low for the users as well as those who merely occupy the adjacent areas, basically due to the relative infrequency with which the station is used. It is unlikely that the modifications discussed in the previous paragraph would result in appreciable reductions in exposures. However, a reduction in required air volume to maintain control could be achieved by extending the upper edge of the hood opening downward to the extent practical, as discussed in recommendation #1 above. Again, after the hood is modified, have the HVAC contractor adjust the flow. Some energy savings would result from this simple measure.

The possibility of absorption of toxic quantities of the solvent through the skin under the conditions of use at this facility is very remote, but cannot be ruled out. As noted in Section IV.A. of this report, it is very unlikely that dermal absorption will be of as great of importance as inhalation for petroleum distillates such as mineral spirits. In this facility, even the inhalation exposures are small. Nevertheless, an employee with symptoms resembling those of mineral spirits exposure should try wearing gloves during parts cleaning, over an extended period (e.g., 1 mo), to see if his symptoms abate. If they do, then the possibility that the affected employee had been absorbing a toxic dose through the skin will become more plausible.

At this facility, a wide variety of other chemical products are used intermittently and for brief periods as cleaning solvents and for other purposes. The usage of some of these should be reviewed. These include Conformal Coating PH 1500, Heavy Duty Silicone & 12-26 Aerosol #2004, and Loktite, which contain 35%, 38%, and 90% 1,1,1-trichloroethane, respectively. NIOSH, in its Current Intelligence Bulletin (CIB) #27, recommends that 1,1,1-trichloroethane be treated in the workplace with caution because of its relation to four other chloroethanes shown to be carcinogenic in laboratory animals. Also, Flux-Off contains 48.5% methylene chloride, the carcinogenicity of which has been documented in several studies of chronic effects in animals. On this basis, NIOSH, in its CIB #46, recommends regarding methylene chloride as a "potential occupational carcinogen" and controlling occupational exposure to the lowest feasible limit.

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IX. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Snap-on Tools Eastern Service Center
2. OSHA, Region III
3. NIOSH, Region Cincinnati

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table I  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387  
 Personal Air Sampling Results for Mineral Spirits

Date 1986	Sample Number	Job/Area	Time		Volume (L)	Concentration (mg/m <sup>3</sup> )
			Start	Stop		
Jun 26	CT-1	Technician/Pneumatic (South)	7 10	15 28	10	31*
Jun 26	CT-2	Technician/Pneumatic (South)	7 12	15 20	10	58
Jun 26	CT-3	Technician/Pneumatic (South)	7 14	15 19	10	62
Jun 26	CT-4	Technician/Pneumatic (South)	7 15	15 19	10	20*
Jun 26	CT-5	Technician/Pneumatic (North)	7 16	15 21	11	37
Jun 26	CT-6	Technician/Pneumatic (North)	7 17	15 22	10	81
Jun 26	CT-7	Technician/Pneumatic (North)	7 18	15 28	11	94
Jun 26	CT-8	Technician/Pneumatic (North)	7 19	15 22	10	68
Jun 27	CT-25	Technician/Pneumatic (South)	7 00	15 20	10	30*
Jun 27	CT-26	Technician/Pneumatic (South)	7 01	15 19	10	39
Jun 27	CT-27	Technician/Pneumatic (South)	7 02	15 17	10	51
Jun 27	CT-28	Technician/Pneumatic (South)	7 03	15 18	10	30*
Jun 27	CT-29	Technician/Pneumatic (North)	7 04	15 17	11	63
Jun 27	CT-30	Technician/Pneumatic (North)	7 05	15 18	10	59
Jun 27	CT-31	Technician/Pneumatic (North)	7 05	15 20	11	56
Jun 27	CT-32	Technician/Pneumatic (North)	7 06	15 16	11	95

\* Below the limit of quantitation; therefore, the reported value lacks precision.

Table II  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387  
 Personal Air Sampling Results for Mineral Spirits, Statistical Summary

Job/Area	N	Minimum	Maximum	Standard		Geometric		95% LCL	95% UCL
				Mean	Error	Mean	GSD		
All	16	20	95	55	5.7	50	1.57	39	64
Tech/Pneumatic (North)	8	37	95	69	7.1	66	1.37	51	86
Tech/Pneumatic (South)	8	20	62	40	5.4	38	1.48	27	52

Table III  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387  
 Area Air Sampling Results for Mineral Spirits

Date	Sample Number	Area	Time		Volume (L)	Concentration (mg/m <sup>3</sup> )
			Start	Stop		
1986						
Jun 26	CT-9	Pneumatic (North), Work Bench	7 21	15 21	10.2	29
Jun 26	CT-12	Pneumatic (South), Work Bench	7 26	15 19	10.0	20*
Jun 26	CT-15	Electrical (Center), Work Bench	7 34	15 29	10.0	<20**
Jun 26	CT-16	Torque, Work Bench	7 34	15 30	10.3	<19
Jun 26	CT-21	Pneumatic, Testing Room	7 45	15 23	9.2	22
Jun 27	CT-33	Pneumatic (North), Work Bench	7 07	15 16	10.5	29
Jun 27	CT-36	Pneumatic, Testing Room	7 09	15 21	10.3	29
Jun 27	CT-37	Pneumatic (South), Work Bench	7 11	15 20	10.5	19*
Jun 27	CT-40	Electrical (Center), Work Bench	7 14	15 22	10.6	<19
Jun 27	CT-41	Torque, Work Bench	7 16	15 22	10.0	<20

\* Below the limit of quantitation; therefore, the reported value lacks precision.

\*\* "Less than" (<) indicates that the concentration was below the reported value, which is the detection limit for the sample.

Table IV  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387  
 Area Air Sampling Results for Mineral Spirits, Statistical Summary

Area	N	Standard Geometric							
		Minimum	Maximum	Mean	Error	Mean	GSD	95% LCL	95% UCL
All	10*	9	29	19	2.69	17	1.64	12	24
Pneumatic, testing room	2	22	29	25	3.76	25	1.23	4	167
Torque, work bench	2	<20**	<20	--	--	--	--	--	--
Electrical (Center), work bench	2	<19	<20	--	--	--	--	--	--
Pneumatic (South), work bench	2	19	20	20	0.48	20	1.04	14	27
Pneumatic (North), work bench	2	29	29	29	0.43	29	1.02	24	35

\* Grouping contains no more than 50% "less than" (<) values (which are below the detection limit); one half of the value of each such sample is used for calculation of summary statistics.

\*\* "Less than" (<) indicates that the concentration was below the reported value, which is the detection limit for the sample.

Table V  
 Snap-On  
 June 26-27, 86  
 HETA 86-387

## Results of Process Air Samples (at exhaust hoods) for Mineral Spirits, Individual Samples

Date 1986	Sample Number	Location	Time		Volume (L)	Concentration (mg/m <sup>3</sup> )
			Start	Stop		
Jun 26	CT-10	Pneumatic(North),left(target)	7 23	13 13	8.1	124
Jun 26	CT-22	Pneumatic(North),left(target)	13 15	15 27	3.1	98
Jun 26	CT-11	Pneumatic (North), right	7 24	13 18	7.4	135
Jun 26	CT-23	Pneumatic (North), right	13 21	15 28	2.7	110
Jun 26	CT-13	Pneumatic(South),top center	7 27	13 22	6.9	72
Jun 26	CT-24	Pneumatic(South),top center	13 25	15 24	2.6	77*
Jun 26	CT-14	Torque,inside,center	7 30	15 29	10.2	79
Jun 27	CT-34	Pneumatic (North), right	7 08	11 50	6.6	152
Jun 27	CT-46	Pneumatic (North), right	11 51	14 11	4.7	425
Jun 27	CT-35	Pneumatic(North),left(target)	7 08	11 53	5.9	135
Jun 27	CT-47	Pneumatic(North),left(target)	11 54	15 15	4.2	94
Jun 27	CT-38	Pneumatic(South),top center	7 12	11 46	5.9	51*
Jun 27	CT-48	Pneumatic(South),top center	11 48	15 21	4.6	66*
Jun 27	CT-39	Torque,inside,center	7 13	15 21	10.2	88

\* Below the limit of quantitation; therefore, the reported value lacks precision.

Table VI  
 Snap-On  
 June 26-27, 86  
 HETA 86-387

Results of Process Air Samples (at exhaust hoods) for Mineral Spirits, 8-hr TWAs

Date 1986	Sample Number	Location	Time (min)	Volume (L)	Concentration (mg/m <sup>3</sup> )
Jun 26	CT-10-22	Pneumatic(North),left(target)	482	11.1	117
Jun 26	CT-11-23	Pneumatic (North), right	481	10.1	128
Jun 26	CT-13-24	Pneumatic(South),top center	474	9.5	74*
Jun 26	CT-14	Torque,inside,center	479	10.2	79
Jun 27	CT-34-46	Pneumatic (North), right	422	11.3	266
Jun 27	CT-35-47	Pneumatic(North),left(target)	486	10.2	118
Jun 27	CT-38-48	Pneumatic(South),top center	487	10.4	58**
Jun 27	CT-39	Torque,inside,center	488	10.2	88

\* One of the constituent samples was below the limit of quantitation. \*\*

\*\* Below the limit of quantitation; therefore, the reported value lacks precision.

Table VII  
 Snap-On  
 June 26-27, 86  
 HETA 86-387

Results of Process Air Samples (at exhaust hoods) for Mineral Spirits, 8-hr TWAs, Statistics

Location	N	Standard Geometric				Mean	GSD	95% LCL	95% UCL
		Minimum	Maximum	Mean	Error				
Torque,inside,center	2	79	88	83	4.79	83	1.08	40	173
Pneumatic(South),top center	2	58	74	66	8.09	65	1.19	13	314
Pneumatic (North), right	2	128	266	197	68.95	185	1.68	2	19159
Pneumatic(N),left(target)	2	117	118	117	0.58	117	1.01	110	125
All	8	58	266	116	23.15	104	1.60	70	154

Table VIII  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387

Short-term sampling results for hydrocarbons (from direct-reading devices).

Date (1986)	Personal, Area, or Process (Pe, A, Pr)	Description of Sample Detector tube (DT) or H*Nu	Type of Sample Solvent Station	Concentration, Compared to mg/m <sup>3</sup> Process Sample
26 Jun	Pr Solvent Station, Pneumatic Area (North)	DT	-----	800(+300)
	" " " (South)	DT	-----	*
27 Jun	Pr " " " (North)	H*Nu	(same)	(/800)
	Pe Pneumatic: cleaning a (north) part	H*Nu	1/8, peaks to 1/4	(100, peaks to 200)
	" " at bench	H*Nu	1/16	(/50)
	" " clean, dry, return to bench	H*Nu	1/8, 1/4 to 3/8, < 1/8	(100, 200- 300, <100)
	" (south) " "	H*Nu	1/16, > 1/16, 1/20	(50, >50, 40)
	A " " @ bench	H*Nu	1/20	(/40)
	Packaging	H*Nu	1/32	(/25)
	Background - Outdoors	H*Nu	1/50	(/15)

\* Value was approximately the same as the previous sample; since about 90 strokes were required for a full color change, the color change on this tube was not completed.

Table IX  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387  
 Air Sampling Results for Calcium

Date 1986	Sample Number	Sample Type/Area	Time		Volume (L)	Concentration (mg/m <sup>3</sup> )
			Start	Stop		
Jun 26	AA-1	PROCESS/Pneumatic, North, Left	8 28	15 28	1092	0.0073
Jun 26	AA-2	PROCESS/Pneumatic, South, Left	8 31	15 26	1100	0.0064
Jun 26	AA-3	BACKGROUND AREA/Pneumatic	8 33	15 27	1076	<0.0005*
Jun 27	AA-6	PROCESS/Pneumatic, North, Left	7 36	15 13	1188	0.0017**
Jun 27	AA-7	BACKGROUND AREA/Pneumatic	7 36	15 13	1188	0.0059

\* "Less than" (<) indicates that the concentration was below the reported value, which is the detection limit for the sample.

\*\* Below the limit of quantitation; therefore, the reported value lacks precision.

Table X  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387  
 Air Sampling Results for Chromium (total)

Date 1986	Sample Number	Sample Type/Area	Time		Volume (L)	Concentration (mg/m <sup>3</sup> )
			Start	Stop		
Jun 26	AA-1	PROCESS/Pneumatic, North, Left	8 28	15 28	1092	<0.003*
Jun 26	AA-2	PROCESS/Pneumatic, South, Left	8 31	15 26	1100	<0.003
Jun 26	AA-3	BACKGROUND AREA/Pneumatic	8 33	15 27	1076	<0.003
Jun 27	AA-6	PROCESS/Pneumatic, North, Left	7 36	15 13	1188	<0.003
Jun 27	AA-7	BACKGROUND AREA/Pneumatic	7 36	15 13	1188	<0.003

\* "Less than" (<) indicates that the concentration was below the reported value, which is the detection limit for the sample.

Table XI  
Snap-On Tools  
June 26-27, 1986  
HETA 86-387  
Air Sampling Results for Chromium (VI)

Date 1986	Sample Number	Sample Type/Area	Time Start	Time Stop	Volume (L)	Concentration (mg/m <sup>3</sup> )
Jun 26	PVC-1	PROCESS/Pneumatic, South, Left	8 34	15 26	1071	<0.0007*
Jun 27	PVC-3	PROCESS/Pneumatic, North, Left	7 38	15 13	1320	<0.0005

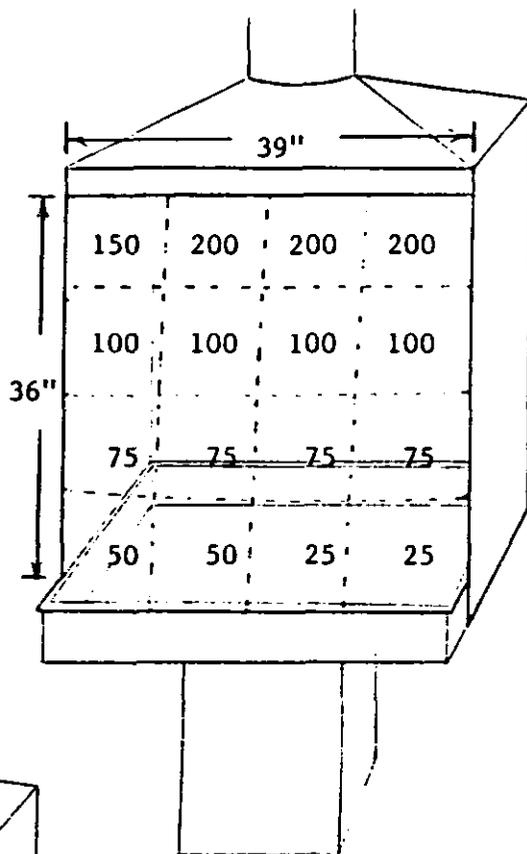
\* "Less than" (<) indicates that the concentration was below the reported value, which is the detection limit for the sample.

Table XII  
 Snap-On Tools  
 June 26-27, 1986  
 HETA 86-387  
 Ventilation Performance Summary.

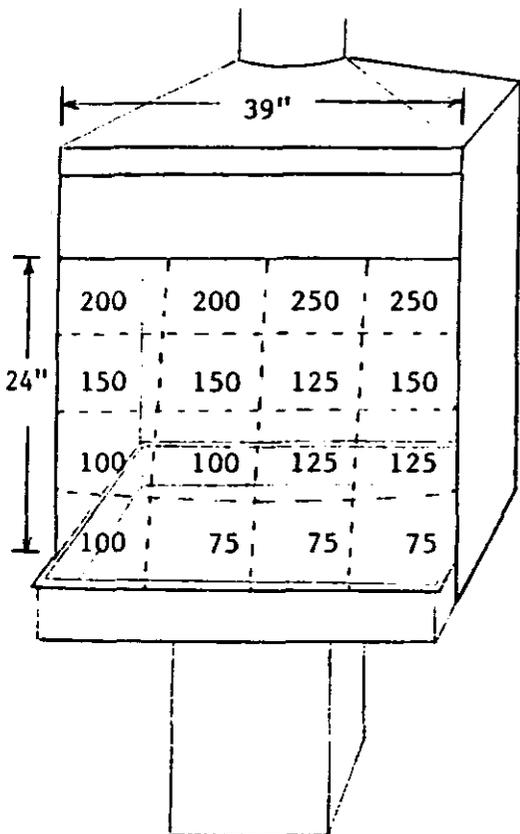
Parameter	Hood Location, Solvent Station		
	Pneumatic-Tool Repair Area	Torque-Tool Repair Area	
	North End	South End	
Average Face Velocity, fpm	100	141	211
Volumetric Flow Rate, cfm	975	916	1930

Figure 1. Results of ventilation system measurements, Snap-On Tools Eastern Service Center, Harrisburg, PA, 26-7 June 1986. Solvent station ventilation hoods. HETA 86-387.

Air velocities in ft/min  
 Dimensions in inches  
 (not drawn to scale)



Pneumatic-tool  
 repair area,  
 north end



Pneumatic-tool  
 repair area,  
 south end

Torque-tool  
 repair area

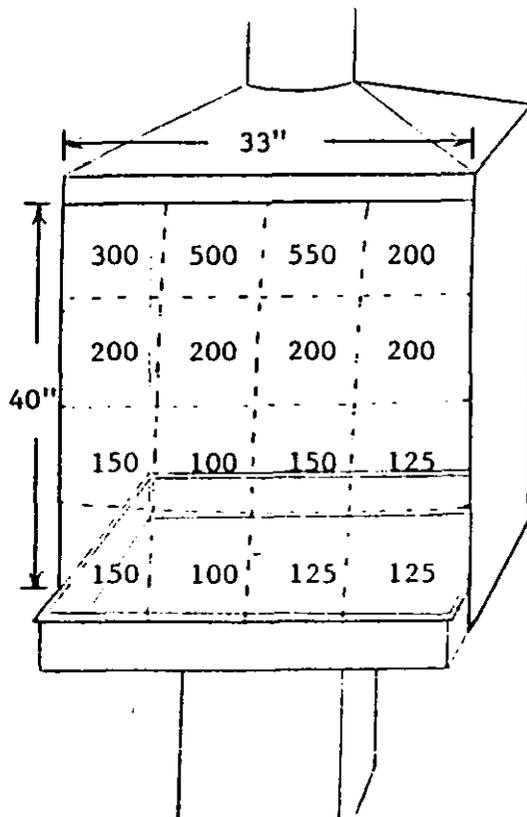
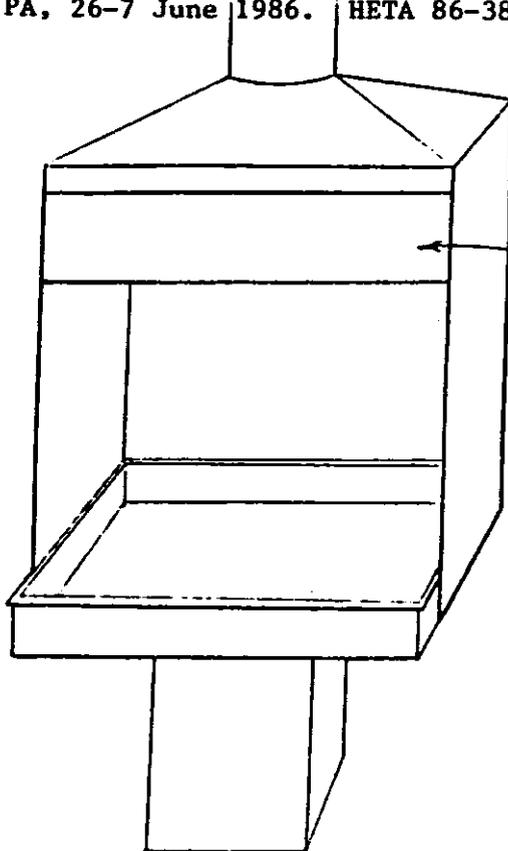


Figure 2. Recommendations for modification of the ventilation hoods on the solvent stations. Snap-On Tools Eastern Service Center, Harrisburg, PA, 26-7 June 1986. HETA 86-387.

Recommendation 1.

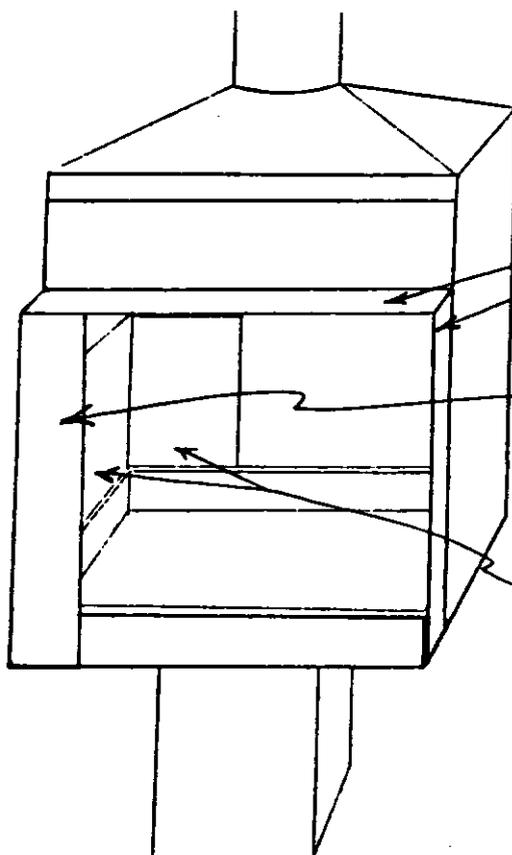
Hood shown similar to current configuration in pneumatic-tool repair area, south end.



Additional panel which lowers the upper edge of the opening.

Recommendation 2.

Modified hood shown.



Extension "curtains".

Extension across front of basin.

"Target" filters (2), turned upright.